Provincial Report

Grade 9 Science Achievement Test
October 1985

Student Evaluation

Alberta
EDUCATION

Distribution:

Superintendents of Schools
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EXECUTIVE SUMMARY

Description of the Test

The test contains 75 multiple-choice questions covering six major concepts based on the subject matter and process skills components of the Grade 9 Science core curriculum. The number of questions and the percentage emphasis given to each major concept are:

Major Concept	No. of Questions	Emphasis (%)
Matter Occupies Space	13	17
Kinetic Molecular Theory	19	26
Heat and Temperature	18	24
Energy	7	9
Atoms and Molecules	10	13
Process Skills	8	11

Eleven of the 75 questions are taken from the Minister's Advisory Committee on Student Achievement (MACOSA) Science Test, administered in 1978.

Administration

The test was administered on June 11, 1985 to 29 639 students enrolled in Grade 9 Science.

Results

The provincial averages in raw scores for each major concept and the total test are:

Matter Occupies Space	9.6
Kinetic Molecular Theory	13.1
Heat and Temperature	10.9
Energy	4.7
Atoms and Molecules	6.3
Process Skills	5.0
Total Test	49.6

The percentage of Grade 9 Science students who correctly answered the 11 MACOSA questions was greater than it was in 1978. The 1985 average score was 62.4% compared with the 1978 average score of 54.7%.

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ACKNOWLEDGMENTS

The successful administration of the Grade 9 Science Achievement Test was due to the concerted effort of all involved. Success would not have been possible without substantial contributions from many people, particularly the administrators, teachers, and students, who extended their full cooperation.

The advice received from the Test Review Committee regarding design, development, and reporting has been valuable in the implementation of the Achievement Testing Program. This Committee has representation from:

The Alberta Teachers' Association
The Conference of Alberta School Superintendents
The Universities
Alberta Education

The technical expertise provided by Dr. T. O. Maguire, Professor, Division of Educational Research Services, University of Alberta, has contributed greatly to the advancement of the Achievement Testing Program and his work in this area is acknowledged and appreciated.

George Bevan
Director
Student Evaluation Branch

Chapter 1

THE ACHIEVEMENT TESTING PROGRAM

The Achievement Testing Program provides information significant at the provincial and local levels about student knowledge, understanding, and skills in relation to program objectives.

The achievement tests are specific to the program of studies prescribed by the Minister of Education. Curriculum specifications for each subject area, provided by the Curriculum Branch and the Language Services Branch of Alberta Education, identify the major content areas, the specific learning objectives within each area, and the emphasis that each objective is to receive. The test questions reflect these curriculum specifications.

The achievement tests, administered on a cyclical basis, are in four subject areas: language arts, social studies, mathematics and science; and at three grade levels: 3, 6 and 9. In 1985, achievement tests were administered in Grade 3 Language Arts, Grade 6 Social Studies and Grade 9 Science.

Following the achievement test administration in June of each year, the results are reported to each school jurisdiction. These district profiles include results for each school and each student. Individual statements of results are not issued to students.

This provincial report is designed to assist school jurisdictions in interpreting their achievement test results.

Exemptions from the Achievement Testing Program

Under normal circumstances, the following are exempt from achievement testing:

- Students participating in Special Educational programs
- Students in classes where the subject being tested has been cycled and taught in an alternate year
- Students in classes where the subject being tested has been taught in an alternate semester
- Students enrolled in English as a Second Language Programs

Chapter 2

DESCRIPTION OF THE TEST

Test Design and Development

The development of the Grade 9 Science Achievement Test progressed through three stages: preparation of curriculum specifications, development of questions and selection of questions for the achievement test.

1. Curriculum Specifications

   The Curriculum Branch prepared curriculum specifications based on the *Program of Studies for Junior High Schools*. These specifications identify the major content areas and the emphasis each is to receive in the program. The curriculum specifications were distributed to all school jurisdictions in the province.

2. Development of Questions

   The Student Evaluation Branch of Alberta Education prepared the test blueprint based on the emphases identified in the curriculum specifications. Test questions were developed by Grade 9 Science teachers from all parts of the province under the supervision of the Student Evaluation Branch. The questions were field-tested on year-end tests. Revisions were made to the questions on the basis of teacher recommendations and field-test results.

3. Achievement Test

   The achievement test was constructed from the questions that best reflect curricular intent and test design requirements. The Test Review Committee reviewed the test for content validity, accuracy and technical merit. Final revisions, based on the recommendations of this committee, were made to the test.

Reporting Categories

The 75 multiple-choice questions on the test are grouped according to six major concepts: matter occupies space, kinetic molecular theory, heat and temperature, energy, atoms and molecules, and process skills. The specific concepts tested within each major concept category are identified in Chapter 5.

Questions are classified according to three cognitive levels: knowledge, application and understanding, and higher mental activities. The classification of test questions according to cognitive level depends on the manner in which the content has been covered in the classroom. A question that is an application question for one class may be a knowledge question for another. Teachers may wish to examine this classification to determine whether it is consistent with the way they taught the material.

The classification of questions according to major concepts and cognitive levels is identified in the test blueprint, presented in Table 1. An explanation of cognitive levels is given in the appendix.

Test Blueprint

Table 1

Classification of Test Questions

MAJOR CONCEPT / COGNITIVE LEVEL	KNOWLEDGE	APPLICATION AND UNDERSTANDING	HIGHER MENTAL ACTIVITIES	TEST EMPHASIS (%)
9.1 Matter occupies space	1,2,8	4,5,6,7,9,10, 12,13	3,11	17
9.2 Kinetic molecular theory	14,21,26, 30,31	15,17,18,19, 20,22,23,24, 25,28,32	16,27,29	26
9.3 Heat and temperature	33,40	34,35,36,37, 38,39,41,43, 44,45,46,47, 49	42,48,50	24
9.4 Energy	51,57	52,54,55,56	53	9
9.5 Atoms and molecules	66	58,59,62,63, 64,65,67	60,61	13
Process skills	70,75	68,69,71,72, 73	74	11
TEST EMPHASIS (%)	20	64	16	100

Chapter 3

ADMINISTRATION OF THE TEST

Test Population

All Grade 9 students were expected to write the Science Achievement Test. Exemptions from writing were approved by superintendents under specific conditions.

Administrative Procedures

Jurisdictions were requested in April to report the number of students enrolled in Grade 9 Science in each school. In May, letters were sent to the superintendents and principals regarding the test schedule, procedures for test administration and requirements for returning test materials. Information addressed to the teachers related to the administration of the test and the return of test materials. Jurisdictions were sent the appropriate number of tests and administration instructions, packaged according to school. Immediately after the test was administered, teachers were instructed to collect all test booklets and answer sheets and return them to the principal for forwarding to school board offices. School Boards were responsible for sending the test booklets and answer sheets to the Student Evaluation Branch.

Staff from the Regional Offices of Education supervised the administration of the test in private schools.

Standard-Setting

While provincial averages are useful for comparing the scores of students in a particular school or jurisdiction with overall levels of achievement, it is not possible to know whether the students in the province did as well as they should have. A test score by itself has limited meaning without comparison to a standard. Tests vary in difficulty: a raw score of 25 out of 50, for example, could represent very high achievement on one test, and very low achievement on another.

To establish standards that allow the assessment of achievement on the test, the Student Evaluation Branch asked forty experienced Grade 9 Science teachers to examine each question on the test and determine the expected difficulty level of that question for two groups of students: border-line passing students and borderline honors students. From the individual question difficulty levels, the overall test difficulty levels expected for

these two groups were determined. The averages of the test difficulty levels established by the teachers provided the standards for minimum performance and honors performance on the test. For the Grade 9 Science Achievement Test the standards established were as follows:

To meet the minimum performance level, students should achieve a raw score of 38.0.

To meet the minimum honors performance level, students should achieve a raw score of 64.0.

Chapter 4

RESULTS

The report is based on the results for the 29 639 students from public and separate schools.

Total Test

Since over 28 580 of the students completed the test, it was concluded that sufficient time was allowed to write the test. Test statistics are as follows:

	Raw Score	Percentage
Provincial Average	49.6	66.2
Standard Deviation	12.5	16.7
KR-20 Coefficient	0.9111	

The percentage of students meeting the minimum performance level of achievement on the test was 81.3%.

The percentage of students meeting the minimum honors performance level of achievement on the test was 14.3%.

Table 2 presents total raw scores as well as the relative frequency and the cumulative frequency for each raw score. The range of scores was from 6 to 75. Any relative frequency or any cumulative frequency smaller than 0.05 was rounded to 0.0. For example, 5 students or 0.02% obtained a score of 13, but the relative frequency for this score is recorded as 0.0.

Table 2

Frequency Distribution of Raw Scores

Raw Score	Relative Frequency (%)*	Cumulative Frequency (%)**	Raw Score	Relative Frequency (%)*	Cumulative Frequency (%)**
6	0.0	0.0	43	2.3	31.2
7	0.0	0.0	44	2.3	33.5
10	0.0	0.0	45	2.4	35.9
12	0.0	0.0	46	2.5	38.5
13	0.0	0.0	47	2.7	41.2
14	0.0	0.1	48	2.7	43.9
15	0.1	0.1	49	2.8	46.8
16	0.1	0.2	50	2.8	49.5
17	0.1	0.3	51	2.9	52.4
18	0.1	0.5	52	2.8	55.1
19	0.3	0.7	53	2.9	58.0
20	0.2	1.0	54	2.9	60.9
21	0.3	1.3	55	2.9	63.8
22	0.4	1.7	56	2.8	66.6
23	0.4	2.1	57	2.9	69.5
24	0.6	2.8	58	2.9	72.4
25	0.7	3.5	59	2.9	75.2
26	0.7	4.2	60	2.7	77.9
27	0.8	5.0	61	2.6	80.5
28	1.0	6.0	62	2.7	83.2
29	1.0	7.0	63	2.4	85.7
30	1.1	8.1	64	2.3	88.0
31	1.3	9.3	65	2.2	90.2
32	1.3	10.7	66	2.2	92.3
33	1.4	12.1	67	1.6	93.9
34	1.5	13.6	68	1.5	95.4
35	1.5	15.2	69	1.5	96.9
36	1.6	16.8	70	1.1	98.0
37	1.9	18.7	71	0.8	98.7
38	1.8	20.5	72	0.6	99.4
39	2.2	22.7	73	0.4	99.7
40	1.9	24.6	74	0.2	100.0
41	2.0	26.6	75	0.0	100.0
42	2.3	28.9			

*Relative frequency: the percentage of students who obtained each score

**Cumulative frequency: the percentage of students who scored at or below each score

Reporting Categories

Table 3 gives details about scores in the reporting categories. Provincial averages for these categories and for the total test were computed and rounded to one decimal. Consequently, the sum of the averages is not exactly the same as the average for the total test.

Table 3

Provincial Averages for Major Concepts, Cognitive Levels and Total Test

Reporting Category	Number of Questions	Average in Raw Score	Standard Deviation of Raw Score
Major Concept			
Matter Occupies Space	13	9.6	2.5
Kinetic Molecular Theory	19	13.1	3.7
Heat and Temperature	18	10.9	3.6
Energy	7	4.7	1.6
Atoms and Molecules	10	6.3	2.2
Process Skills	8	5.0	1.9
Cognitive Level			
Knowledge	15	10.9	2.8
Application & Understanding	48	31.2	8.4
Higher Mental Activities	12	7.6	2.3
Total Test	75	49.6	12.5

Results for Individual Questions

The percentage of students choosing each response is given in Table 4. The correct response for each question is also identified.

Table 4

Results for Individual Questions

Item	Key	Distribution of Responses in %*				Item	Key	Distribution of Responses in %*			
		A	B	C	D			A	B	C	D
1	D	3.8	16.0	5.3	74.7	39	B	5.5	67.9	5.8	20.8
2	C	1.6	14.8	80.8	2.8	40	C	12.1	6.8	76.3	4.8
3	B	16.4	65.8	12.4	5.3	41	C	22.0	12.8	47.5	17.6
4	A	80.8	7.3	5.2	6.7	42	A	42.9	13.8	29.7	13.4
5	A	79.7	4.4	13.5	2.3	43	B	13.3	26.5	8.6	51.5
6	D	11.7	11.7	19.3	57.0	44	D	8.6	3.9	3.8	83.7
7	B	7.5	74.9	6.2	11.3	45	D	12.5	4.6	10.6	72.2
8	B	6.2	76.1	4.8	12.9	46	D	3.4	6.4	17.8	72.3
9	B	23.3	68.6	6.0	2.0	47	D	10.7	11.6	5.1	72.5
10	C	3.2	3.5	86.5	6.8	48	D	2.8	11.1	37.9	48.1
11	C	8.9	4.9	72.1	14.0	49	D	2.3	21.8	2.2	73.6
12	B	17.1	62.4	5.9	14.6	50	C	31.3	12.3	37.3	18.9
13	A	83.6	2.5	8.9	4.9	51	C	18.2	3.9	71.2	6.6
14	A	59.2	11.2	15.1	14.4	52	B	14.6	57.8	11.8	15.7
15	C	3.9	11.0	74.1	10.9	53	C	3.9	21.0	69.3	5.7
16	B	2.1	89.3	1.9	6.7	54	A	68.9	13.2	9.8	8.0
17	A	65.9	14.6	9.7	9.6	55	B	33.8	43.8	14.0	8.2
18	C	16.9	27.5	47.6	8.0	56	A	81.8	1.4	3.6	13.2
19	C	3.5	17.5	74.0	5.0	57	D	9.2	4.6	6.7	79.5
20	A	67.7	12.3	9.8	10.1	58	C	5.2	20.2	70.8	3.8
21	C	12.3	7.2	77.2	3.3	59	D	8.8	20.1	6.8	64.2
22	B	8.7	76.0	4.3	11.0	60	A	59.5	15.7	20.7	3.8
23	C	17.1	7.4	67.3	8.1	61	C	5.8	6.5	84.1	3.5
24	A	72.0	6.9	2.7	18.3	62	B	22.9	57.1	11.6	8.4
25	A	87.9	4.3	3.6	4.1	63	B	12.7	61.8	12.4	12.9
26	A	86.5	4.1	6.5	2.8	64	B	18.4	47.6	12.5	21.3
27	B	8.4	59.7	25.9	5.9	65	A	58.8	15.0	9.1	16.9
28	A	37.7	20.2	16.4	25.6	66	B	7.9	55.8	19.6	16.5
29	D	26.1	8.6	2.5	62.7	67	B	27.7	66.2	3.1	2.8
30	B	8.8	71.0	9.8	10.3	68	D	27.9	12.1	6.4	53.3
31	C	10.5	4.6	69.4	15.4	69	C	28.7	14.1	44.2	12.8
32	A	69.3	19.2	5.4	6.0	70	D	16.9	7.9	14.5	60.5
33	A	66.7	6.5	22.6	4.1	71	A	80.0	12.1	6.5	1.1
34	B	6.7	44.1	24.4	24.6	72	B	22.2	60.2	9.1	8.3
35	C	5.6	20.6	68.8	4.8	73	D	8.0	9.4	27.2	55.2
36	B	4.7	68.8	14.5	12.0	74	C	13.9	11.5	64.9	9.5
37	D	9.6	7.8	20.8	61.6	75	C	3.4	8.7	82.2	5.5
38	D	7.3	27.9	10.2	54.5						

*The sum of the percentages for each question may be less than 100% because the No Response category is not included. The No Response category does not exceed 1% for all questions.

Chapter 5

DISCUSSION AND CONCLUSIONS

Reporting Categories

The results for each of the major concept categories are discussed in detail in the following sections. The concepts tested, the easiest question and the most difficult question within each category are noted. Sample questions from the test are provided. For each sample question, the curriculum concept and the cognitive level are identified. The asterisk (*) indicates the correct response for each question, and the percentage of students who selected each alternative is given.

Matter Occupies Space (Questions 1 to 13)

This subtest comprises questions related to the following concepts:

9.1 Matter occupies space and has mass.

1. Fundamental to the process of science is the establishment of standards for making measurements.
2. Matter can be measured by determining its linear dimensions, surface area and volume.
3. Matter can be measured in terms of its mass and weight.
4. Density is a characteristic property of any given sample of matter and is, therefore, useful for identification purposes.

- The average score for the 13 questions on this subtest was 74.1%.
- Question 10, requiring students to interpolate from a graph, was the easiest (86.5% answered correctly).
- Question 6, requiring students to use the slope method to determine the density of a liquid, was the most difficult (57.0% answered correctly).

Sample question:

Question 3
Concept 9.1.4
Cognitive Level - Higher Mental Activities

In this question, students are required to analyse the observations and determine the relative masses (hence densities) of the three blocks.

3. A student was given three blocks of different metals that were labelled Q, R, and Z. Each block had a volume of 20 cm^3. By using an equal-arm balance, the student found that block Q just balanced blocks R and Z when they were placed together. However, block R was not heavy enough to balance block Z. From this information we know that the blocks, in order of increasing density, are

		Student Responses (%)
A.	Q,R,Z	16.4
*B.	R,Z,Q	65.8
C.	Z,R,Q	12.4
D.	R,Q,Z	5.3

Kinetic Molecular Theory (Questions 14 to 32)

This subtest comprises questions related to the following concepts:

9.2 The forms and behavior of matter can be explained by the Kinetic Molecular Theory.

1. Matter is composed of tiny particles.
2. Molecules are in a state of constant motion.
3. Molecular motion is the basis for diffusion
4. Molecular motion results in evaporation.

- The average score for the 19 questions on this subtest was 69.2%.
- Question 16, requiring students to formulate a hypothesis, was the easiest (89.3% answered correctly).
- Question 28, requiring students to identify the manipulated variable, was the most difficult (37.7% answered correctly).

Sample questions:

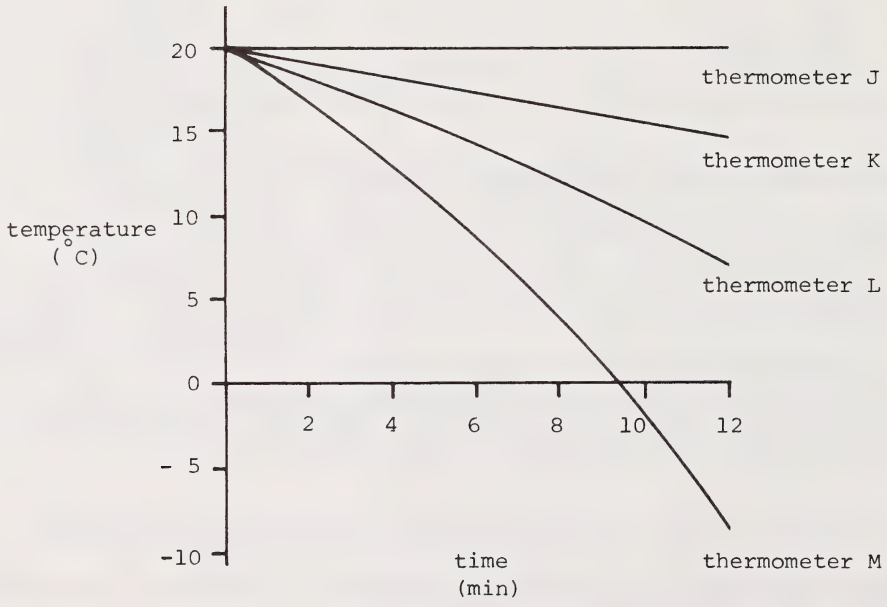
Use the following information to answer questions 27 to 29.

Four thermometer bulbs were each wrapped in a layer of cotton cloth and placed into separate beakers for two minutes.

Thermometer J was placed into a beaker containing air. Thermometer K was placed into a beaker containing liquid K. Thermometer L was placed into a beaker containing liquid L. Thermometer M was placed into a beaker containing liquid M.

After the thermometers were removed from the beakers, the temperature for each thermometer was recorded every minute for 12 minutes.

The results are shown on the graph.



Question 27
Concept 9.2.4d - Different liquids evaporate at different rates.
Cognitive Level - Higher Mental Activities

In this question, students are required to analyse the experimental design and determine the appropriate problem statement.

27. What is the problem that was being investigated in this experiment?

	Student Responses (%)
A. What effect does the type of cloth have on the rate of evaporation?	8.4
*B. What effect does the type of liquid have on the rate of evaporation?	59.7
C. What effect does the air temperature have on the rate of evaporation?	25.9
D. What effect does the quantity of liquid have on the rate of evaporation?	5.9

Question 28
Concept 9.2.4d
Cognitive Level - Application and Understanding

In this question, students are required to identify the manipulated (independent) variable in the experiment.

28. The manipulated (independent) variable in this experiment is the

	Student Responses (%)
*A. type of liquid	37.7
B. air temperature	20.2
C. cotton wrapping	16.4
D. rate of evaporation	25.6

Question 29
Concept 9.2.4d
Cognitive Level - Higher Mental Activities

In this question, students are required to infer that the substance having the highest rate of temperature change is the substance having the highest rate of evaporation.

29. According to the graph, the substance that has the highest rate of evaporation is

	Student Responses (%)
A. air	26.1
B. liquid K	8.6
C. liquid L	2.5
*D. liquid M	62.7

Heat and Temperature (Questions 33 to 50)

This subtest comprises questions related to the following concepts:

9.3 Heat and temperature can be explained in terms of molecular motion.

1. Heat and temperature are related.
2. Matter exists in different states.
3. A relationship exists between molecular motion and volume occupied by matter.

- The average score for the 18 questions on this subtest was 60.3%.
- Question 44, requiring students to understand how surface characteristics affect the ability of an object to absorb heat, was the easiest (83.7% answered correctly).
- Question 43, requiring students to identify the liquid having the highest freezing temperature, was the most difficult (26.5% answered correctly).

Sample question:

Question 35
Concept 9.3.1
Cognitive Level - Application and Understanding

In this question, students are required to apply the algorithm $Q = mc\Delta t$.

35. How much heat energy is required to raise the temperature of 100 g of water from 15°C to 30°C?
Note: Specific heat of water = 4200 J/kg•°C.

	Student Responses (%)
A. 21 J	5.6
B. 1500 J	20.6
*C. 6300 J	68.8
D. 26 460 J	4.8

Energy (Questions 51 to 57)

This subtest comprises questions related to the following concepts:

9.4 Energy enables work to be done and motion to be changed.

1. Energy can be described as either kinetic or potential energy.
2. Energy is present in the universe in several forms.
3. One form of energy can be changed into another.

- The average score for the 7 questions on this subtest was 67.5%.

- Question 56, requiring students to apply the principles of energy transformation, was the easiest (81.8% answered correctly).

- Question 55, requiring students to identify an energy transformation, was the most difficult (43.8% answered correctly).

Sample question:

Question 51
Concept 9.4.1
Cognitive Level - Knowledge

In this question, students are required to recall the definition of potential energy.

51. The energy of a mass held 10 m above the ground is said to be

		Student Responses (%)
A.	kinetic	18.2
B.	chemical	3.9
*C.	potential	71.2
D.	mechanical	6.6

Atoms and Molecules (Questions 58 to 67)

The subtest comprises questions related to the following concepts:

9.5 Matter is composed of atoms and molecules.

1. Theories and/or models have been developed to assist in understanding atoms.
2. A relationship exists between atoms and molecules.
3. A relationship exists among elements, compounds and mixtures.
4. There is a different between physical and chemical change.

- The average score for the 10 questions on this subtest was 62.6%.
- Question 61, requiring students to apply newly discovered knowledge, was the easiest (84.1% answered correctly).
- Question 64, requiring students to evaluate the usefulness of procedures, was the most difficult (47.6% answered correctly).

Sample question:

Use the following information to answer question 63.

Blue copper sulphate turns white when heated because water is driven off. A student obtained the following results when heating some copper sulphate:

Mass of beaker	48.7 g
Mass of beaker containing unheated copper sulphate	319.0 g
Mass of beaker containing heated copper sulphate	204.2 g

Question 63
Concept 9.5.1
Cognitive Level - Application and Understanding

In this question, students are required to calculate the mass of water in unheated copper sulphate from the data.

63. What was the mass of water in the unheated copper sulphate?

	Student Responses (%)
A. 163.5 g	12.7
*B. 114.8 g	61.8
C. 67.1 g	12.4
D. 66.5 g	12.9

Process Skills (Questions 68 to 75)

While the process skills component of the Grade 9 Science curriculum is integrated with the subject matter component throughout the test, an attempt was made in this subtest to isolate the process skills component.

The subtest comprises questions related to the following process skills:

1. Interpreting data
2. Applying newly discovered knowledge
3. Formulating hypotheses
4. Controlling variables
5. Designing experiments

- The average score for the 8 questions on this subtest was 62.6%.
- Question 75, requiring students to select the definition for "hypothesis," was the easiest (82.2% answered correctly).
- Question 69, requiring students to compute an average from data presented in a bar graph, was the most difficult (44.2% answered correctly).

Sample question:

Use the following information to answer question 74.

A Grade 9 Science class listed the variables that they thought might affect the time required to melt an ice cube. The list included:

mass of the ice cube
temperature of the room
shape of the ice cube

One student decided to test the hypothesis that the shape of an ice cube affects the time required to melt the ice cube.

Question 74
Process Skill - Designing experiments
Cognitive Level - Higher Mental Activities

In this question, students are required to evaluate the applicability of an experimental design to the hypothesis.

74. Which design should the student select to test this hypothesis?	Student Responses (%)
A. Use five ice cubes, each with a different shape and mass. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.	13.9
B. Use five ice cubes, all having the same shape, but each having a different mass. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.	11.5
*C. Use five ice cubes, all having the same mass, but each having a different shape. Use five identical containers, all at the same temperature. Observe the melting time of the ice cubes.	64.9
D. Use five ice cubes, all having the same mass, but each having a different shape. Use five identical containers, each at a different temperature. Observe the melting time of the ice cubes.	9.5

Comparison With the 1978 MACOSA Results

In 1978, the Minister's Advisory Committee on Student Achievement (MACOSA) Science Test was administered to Grade 9 Science students in Alberta. Eleven questions from that test are included on the 1985 Grade 9 Science Achievement Test. The percentage of students answering each of the common questions correctly and the means for the two administrations are:

Question Number	1978 MACOSA Results (%)	1985 Results (%)
2	65.0	80.8
8	77.1	76.1
46	68.0	72.3
64	43.9	47.6
65	47.0	58.8
66	50.0	55.8
68	36.8	53.3
69	32.4	44.2
72	56.4	60.2
73	54.0	55.2
75	71.5	82.2
Mean	54.7	62.4

Total Test

In a comparison of process skills questions across the total test, students had more difficulty with questions that required them to identify variables (18 and 28) than they had with questions that required them to identify the problem statement or hypothesis (16, 27, 71 and 74).

The average difficulty levels in the major concept categories show some variation (across the total test). Though an attempt was made, it was impossible to select sets of questions so that the average difficulty level in one category was equal to that in another. Hence the variation might be due to variations in question difficulty rather than in student performance. Student performance in each category approximated the expected level.

Because questions within each cognitive level category vary in difficulty, and because the average difficulty of the questions in each category should not necessarily be equal, no discussion about student performance on the three categories across the total test will be made.

Conclusions

The provincial average for the total test was 66.2%. The percentage of students who achieved the minimum honors level of performance (raw score of 64.0) on the test was 14.3%. The percentage of students who achieved the minimum level of performance (raw score of 38.0) on the test was 81.3%.

Chapter 6

GUIDE TO THE INTERPRETATION OF JURISDICTION RESULTS

In addition to their use in monitoring student achievement for the province as a whole, the results of the Grade 9 Science Achievement Test are useful in comparing achievement in a particular jurisdiction with provincial results. However, care must be exercised in making these comparisons and in drawing conclusions from the data.

The following jurisdiction and school reports are provided under separate cover for each jurisdiction.

1. The Jurisdiction Summary Report contains jurisdiction equivalents of the provincial results that are given in all statistical tables in this report.

2. The School Summary Report contains the school equivalents of the provincial results that are given in all statistical tables in this report.

3. The Individual Student Subtest Results are reported for each school.

These reports are confidential to the jurisdiction.

Differences Between Jurisdiction and Provincial Averages

Jurisdictions are provided with their average scores for each reporting category. These scores may be compared to the provincial average for the same reporting category. However, the importance of the differences between group jurisdiction averages and provincial averages is not always clear. To aid in the interpretation of differences between the averages, jurisdiction and school reports indicate when the difference is unlikely to be due to chance variation in the abilities of students. For the purposes of the provincial testing program, the 95% confidence interval is used. That is to say, if the probability is less than 1 in 20 that the difference is due to chance, the difference is very likely a real difference, and the jurisdiction average is classified as different from the provincial average. The provincial average for that reporting category determines the true population average. The standard deviation for the jurisdiction is used to estimate the standard error of the mean.

Because achievement levels are calculated taking jurisdiction size into consideration, two jurisdictions with the same averages but of different sizes may be classified differently. The larger jurisdiction would be more likely to be above or below average, because the amount of chance variation would be less in larger jurisdictions, and the actual difference would represent a larger variation from the provincial average.

For example, imagine two jurisdictions, A with 25 students writing Test X, and B with 100 students writing Test X. Both jurisdictions have the same average, 54.2; both jurisdictions have a standard deviation of 12.0. The difference between the provincial average and the jurisdiction average is 4.2. A difference this large would be expected 8 times out of 100 for groups of 25 selected at random from the population, and fewer than 3 times out of 1000 for groups of 100. Thus the difference from the provincial average would not be statistically significant for Jurisdiction A, but would be for Jurisdiction B.

When it has been determined that a difference is significant, the direction of the difference is important, particularly for those jurisdictions below the provincial average. These jurisdictions are encouraged to identify the sources of these differences.

School reports contain the same analyses to determine whether the school varies significantly from the provincial mean.

Table 5 on page 22 indicates the percentage of jurisdictions classified as significantly above or below the provincial average for each reporting category.

Distribution of Jurisdiction Levels of Achievement

Table 5 indicates the percentage of jurisdictions classified as significantly above or below the provincial average for each subtest.

Table 5

Distribution of Jurisdiction Levels of Achievement

Subtest	Distribution of Jurisdictions		
	% Below Provincial Average	% Not Different From Provincial Average	% Above Provincial Average
Total Test	26.5	57.7	15.8
Concepts			
Matter Occupies Space	17.5	62.9	19.6
Kinetic Molecular Theory	36.0	48.7	15.2
Heat and Temperature	29.1	56.1	14.8
Energy	14.1	65.6	20.3
Atoms and Molecules	26.2	56.4	17.4
Process Skills	22.3	66.3	11.4
Cognitive Levels			
Knowledge	27.0	57.1	15.8
Application & Understanding	27.9	56.9	15.2
Higher Mental Activities	21.4	66.8	11.7

In examining the test results, the reader must keep in mind that a test score does not indicate why a particular performance occurred, but only that it did occur. After studying the results, the identification of reasons for that performance should be undertaken. There are a variety of factors that should be examined:

1. Student motivation. Consideration should be given to the degree to which students were motivated to perform to their levels of ability.

2. Student ability. While the statistical test of significance is designed to take into consideration fluctuations in the average ability levels of students, it is possible that a group of students with a particularly high or low average ability may come through a system. This is much more likely to be a factor in small systems than in a large one.

3. Readability. The achievement test was designed for a Grade 9 reading level. Jurisdictions should consider the average reading level of their Grade 9 students, as reading levels below Grade 9 will have an effect on test results that will be independent of achievement in science.

4. Teaching and curriculum. Consideration should be given to the type of instruction students have received in the jurisdiction and the adequacy of curricular implementation of the program elements that are included on the test.

There will be other factors that are of importance in particular jurisdictions. School boards wishing to examine further the results in light of local factors are encouraged to establish their own local interpretation panels.

Absentee Rates

If more than 10% of the eligible students in a jurisdiction did not write the test, the reported averages for that jurisdiction may not accurately represent the true averages. Teacher-assigned marks for students who did not write could be compared with teacher-assigned marks for students who did write. If the averages are the same for the two groups, the reported achievement averages are probably representative. If the averages are different, some estimates can be made of what the achievement averages might have been if all students had written the test. Jurisdictions with high absentee rates may wish to contact the Student Evaluation Branch for assistance in estimating their averages.

APPENDIX: EXPLANATION OF COGNITIVE LEVELS

1. Knowledge

   Knowledge is defined as including those behaviors and test situations that emphasize the remembrance, either by recognition or recall, of ideas, material or phenomena. This level comprises knowledge of terminology, specific facts (dates, events, persons, etc.), conventions, classifications and categories, methods of inquiry, principles and generalizations, and theories and structures.

2. Application and Understanding

   Application requires that the student apply an appropriate abstraction (theory, principle, idea, methods) to a new situation.

   Understanding refers to responses that demonstrate comprehension of the literal message contained in a communication. This means that the student is able to translate, interpret or extrapolate. Translation refers to the ability to put a communication into another language. Interpretation involves the reordering of ideas (inferences, generalizations or summaries). Extrapolation is the ability to make estimates or predictions based on an understanding of trends or tendencies.

3. Higher Mental Activities

   Analysis, synthesis and evaluation are included in the category of higher mental activities. Analysis comprises the ability to recognize unstated assumptions, to distinguish facts from hypotheses, to distinguish a conclusion from statements that support it, to recognize facts or assumptions that are essential to a main thesis or to the argument in support of that thesis, to distinguish cause-effect relationships from other sequential relationships and to recognize the point of view of a writer.

   Synthesis is the production of a unique communication, the ability to propose ways of testing hypotheses the ability to design an experiment, the ability to formulate and modify hypotheses and the ability to make generalizations.

   Evaluation is defined as making judgments about the value of ideas, solutions and methods. It involves the use of criteria to appraise the extent to which details are accurate, effective, economical or satisfying. Evaluation includes the ability to apply given criteria to judgments of work done, to indicate logical fallacies in arguments and to compare major theories and generalizations.